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Recreation Benefits From an Improvement in Water Quality at St. Albans Bay, Vermont

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RECREATION BENEFITS FROM AN IMPROVEMENT IN WATER QUALITY AT ST. ALBANS BAY, VERMONT. By Marc Ribaudo, C. Edwin Young, and Donald Epp. Natural Resource Economics Division, Economic Research Service, U.S. Department of Agriculture. Washington, D.C. March 1984. ERS Staff Report No. AGES840127.

ABSTRACT

A 1982 survey of recreationists using the northeastern portion of Lake Champlain indicates that improving the water quality of St. Albans Bay, Vermont, would produce significant economic benefits. St. Albans Bay is currently suffering nutrient enrichment problems from both point and nonpoint sources. Applying the survey data to a travel cost model produced a benefit estimate for clean water of $537,000 per year for recreationists. Recreation benefits for clean water estimated by using the contingent rating method came to $230,000 per year. The two methods are compared and reasons given as to why the contingent rating results may be more accurate.

Key words: St. Albans Bay, recreation, benefits, water quality, demand, travel cost, contingent rating.

A related study is:

THE INFLUENCE OF WATER QUALITY ON THE VALUE OF RECREATIONAL PROPERTIES ADJACENT TO ST. ALBANS BAY, VERMONT. By C. Edwin Young and Frank A. Teti, Natural Resource Economics Division, Economic Research Service, U.S. Department of Agriculture, Washington, D.C. January 1984. ERS Staff Report No. AGES 831116.

Hedonic price functions were estimated to determine the impact of degraded water quality on the value of seasonal homes adjacent to St. Albans Bay on Lake Champlain in northern Vermont. A rating of water quality and a zero-one location variable were used as alternative specifications of water quality. Degraded water quality of the bay had depressed adjacent property values by $4,500 on the average, or about 20 percent, compared with similar nearby properties on the larger but cleaner lake.

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SUMMARY

A study of St. Albans Bay, located on the northeastern portion of Lake Champlain in Vermont, revealed that substantial economic benefits would result from improving water quality. The bay currently experiences increased phosphorus loading from both point and nonpoint sources. This situation has degraded the water quality and decreased the attractiveness of the bay as a recreation site.

A 1982 survey of current and former recreational users of the bay determined user benefits if the bay's water quality was improved. The survey data were applied to a travel cost model. The travel cost model uses travel cost to a recreation site as a proxy for price in estimating demand functions for the site. The contingent rating method was then applied to a subsample of respondents. The contingent rating method is a technique which uses utility information to indirectly measure the benefits from improving environmental quality. The results of these two approaches are presented below:

Method	Annual benefits	10-Year discounted benefits*
	Dollars	Million dollars
Contingent rating	230,300	1.3 to 1.9
Travel cost	536,700	3.1 to 4.4

*Discount rates of 3.9 percent to 11.8 percent.

The benefits estimated using the contingent rating method are less than half those estimated using the travel cost method. This difference is most likely due to structural differences between the two methods. The aggregate nature of the travel cost model probably contributed to an overestimate of benefits. The true benefit measure probably lies closer to the contingent rating results.

Despite the difference in benefit estimates, the improvement of water quality in St. Albans Bay appears to be desirable to recreationists. Substantial recreation benefits would be generated. These results are surprising in light of the small size of the bay, and the availability of substitute sites.

The results represent only a portion of the total benefits. Benefits to homeowners in the form of increased property values are ignored. Also ignored are those potential users who have never used the bay but who are familiar with its existence and potential for recreation through the media or by word of mouth.

No attempt was made to account for the effect of congestion on recreation. Extra benefits from an improvement of water quality in St. Albans Bay may be realized by users of the other sites due to a decrease in congestion at those sites. Conversely, the benefits of cleaner water to current users of the bay may be lessened by an increase in congestion at the bay itself.

INTRODUCTION

This report presents research results estimating the dollar value of recreation benefits which would result from improving the water quality in St. Albans Bay, Vermont. Funds for water quality improvement projects are justified if the dollar value of the benefits are greater than the costs. It is important that the benefits to instream activities, such as recreation, be considered. These benefits must be measured without organized markets from which to gather information.

This report describes the problems affecting St. Albans Bay, presents the survey used to gather data, discusses the application of two benefit estimation techniques, and compares the benefit estimates.

DESCRIPTION OF THE PROBLEM

St. Albans Bay is located on the northeastern portion of Lake Champlain about 30 miles north of Burlington, Vermont. The bay covers approximately 1,700 acres, and has a maximum depth of 40 feet and a mean depth of 27 feet. The shoreline is intensively developed, largely for second home use. Until recently the bay has been a major recreation resource for the area. The local economy depends heavily on the influx of visitors who swim, boat, and fish in the bay.

Over the past 10 years, the flow of nutrients into the bay from point and nonpoint sources has increased the rate of eutrophication. The primary nutrient causing the problem is phosphorus. About 23 percent of the phosphorus loading originates from nonpoint sources, primarily the numerous dairy farms located within the watershed. Most of the remaining 77 percent comes from municipal pollution control facilities.

Symptoms of the pollution in St. Albans Bay are the annual noxious algae blooms and a proliferation of rooted aquatic vegetation. In late summer, when the water is warmest, large mats of floating algae and dense bottom growth seriously detract from recreation in the bay. Local residents think that the water is unhealthy. The bay's public beach has been closed at times because of unsafe water contact conditions. This has adversely affected some individual's perceptions of the bay.

An unpleasant side effect of the dense plant growth is the odor which results when the vegetation washes ashore. During the summer of 1982 mechanical harvesters were used to remove rooted plants near heavily used boating areas. The harvesters failed to collect all of the cut plants and many washed ashore. The plants decayed, and produced an extremely obnoxious odor. Many individuals did not want to use the beach as long as the plants remained, although the water itself appeared to be clean.

Recreational use of the bay has declined because of the problems associated with nutrient loading. This is demonstrated by the decline in attendance at St. Albans Bay State Park, located at the head of the bay. In 1960, annual day attendance at the park was 27,456, and in 1970 it was 25,982 (Vermont Department of Forests... 1982). After 1970, as the eutrophication accelerated and became noticeable, annual attendance declined steadily to a total of 3,261 visitors in 1979. The State ceased active management of the park in 1980.

A significant reduction in total phosphorus loading to the bay would decrease the frequency and severity of aquatic vegetation blooms. Steps are being taken to reduce the flow of phosphorus from both point and nonpoint sources. As part of a benefit-cost study to determine whether such steps are economically justified, the benefits to recreation from improvement of the water bay's quality must be measured. We used an application of the travel cost method and an application of contingent rating. The results of the two methods were compared to test the usefulness of the contingent rating method.

SURVEY DESCRIPTION

The study was divided into two phases. First, we visited preselected public access points on Lake Champlain north of Burlington and east of Grand Isle (figure 1). We examined the socioeconomic and recreation behavior characteristics of the individuals using the survey area. Then we applied the contingent rating method to a sample of individuals contacted during the first phase.

Interview Procedure

A face-to-face survey was designed. The questionnaire consisted of 18 questions divided into two parts, recreation behavior and socioeconomic characteristics. The socioeconomic questions concerned age of respondent, household income, occupation, family size, home address, and local address (See Appendix A). Recreation behavior in general and recreation behavior as it pertained to St. Albans Bay were obtained. Respondents were asked to name the kinds of water recreation in which they engaged, including activities such as lakeside walks and picnics which do not require contact with the water. Respondents were asked about the frequency of their visits to the northeastern portion of Lake Champlain during a season, their familiarity with various recreation sites around this portion of the lake, and if the site at which they were interviewed was their destination or a stopover on their recreation itinerary.

Respondents were also asked if they were familiar with St. Albans Bay and if they had ever used it. The types of recreation activities engaged in at the bay, the individuals' perceptions of the bay's water quality, the year of their last

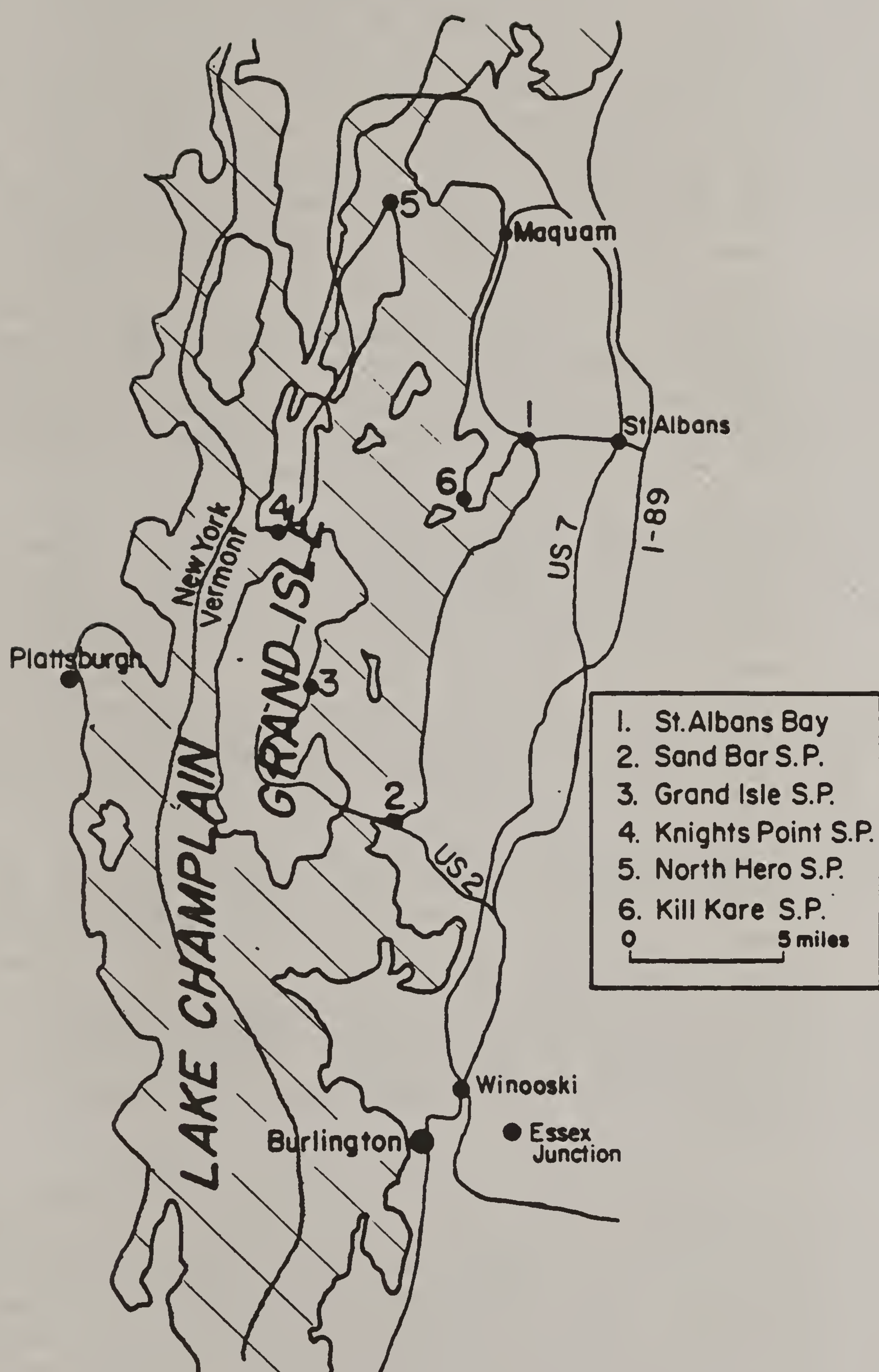

Figure 1. Map of the survey area.

visit to the bay, and the number of visits to the bay in 1982 were also obtained.

An important part of the questionnaire was determining the number of visits to the bay if the water was cleaner. Estimating the number of visits contingent upon water quality required a consistent description of water quality in the hypothetical setting. We decided that using a well-known example of clean water would be the best approach. The eutrophication problem in St. Albans Bay is confined to the bay proper. The water quality of the lake outside the bay and throughout the entire northeast portion is very good. We used the water quality outside the bay as an example of what the water in the bay would be like with pollution control. We believed that most recreationists would be familiar with good quality water. In order to minimize bias, only individuals with some recreational experience at St. Albans Bay were asked to estimate the number of visits that they would make to the bay if the water were cleaner.

One problem in determining the benefits from improving water quality is locating a suitable sample. Many formers users of St. Albans Bay have apparently gone elsewhere for their water recreation. Sampling bay recreationists and determining benefits for them is acceptable if we are only interested in the benefits for this group. The per capita benefits associated with this group may not be applicable to those who have stopped using the bay, but might return if it were cleaner.

There is no reason to assume that those who continue using the bay and those who have stopped will receive the same benefits if water quality is improved. Because the recreationists have chosen different water quality levels, it seems that there are some fundamental differences in taste and behavior between those who continue using the bay and those who stopped using the bay. These differences would likely lead to differences in the benefits derived from an improvement in the bay's water quality.

Our problem was to devise a sampling strategy that included both current users and former users in the survey. One solution was to take a random sample from the population residing in the towns or counties surrounding St. Albans Bay. Contingent valuation methods require that only those familiar with both the recreation site and a cleaner alternative be part of the sample; otherwise, no confidence can be placed in the response because of hypothetical bias. This requires a large survey to collect enough observations to make the results statistically useful.

The recommended alternative was determining where those who are sensitive to pollution may have gone in lieu of St. Albans Bay. There are a number of public access points around the northeastern part of Lake Champlain where displaced recreationists are likely to go. Because public access to the lake is severely limited, we assumed that most of the former St. Albans Bay users became users of the other public sites. They are: Kill Kare State Park, Sand Bar State Park, Knights Point State Park, Grand Isle State Park, and North Hero State Park. Kill Kare is the closest (2 miles) to St. Albans Bay and Grand Isle State Park is the most distant site (38 miles). All the alternative sites have better water quality than St. Albans Bay.

The survey was conducted primarily from July 9-18, 1982, by Marc Ribaudo, with weekend assistance from a University of Vermont student. All alternative sites were visited, as well as St. Albans Bay. At each site recreationists were selected at random as subjects for the survey. Most of the survey time was spent at St. Albans Bay and Kill Kare State Park to ensure that a sufficient number of current and former bay users would be interviewed. We spent two weekend days on the lake in a boat interviewing boaters. This allowed us to expand our survey.

Because many individuals in the sample were interviewed at cleaner sites, because the bay's pollution problem is recent, and because cleaner water is found just outside the bay, we assumed that all of the respondents had some exposure to cleaner water. This leads to confidence in the respondents' ability to assess their recreation behavior in the hypothetical setting.

Comparison of the Groups

A comparison of the two groups' socioeconomic and recreation characteristics may reveal additional benefits from separating the sample. If significant differences appear between the groups for several variables, then separation would increase the homogeneity of each group, thus reducing problems from aggregation and increasing the reliability of the results.

Of the socioeconomic variables we examined (age, occupation, and income), only the income distributions of the two groups were significantly different. The X^2 statistic has a value of 17.97, which is significant at the 1-percent level. The current users tend to have lower incomes than former users. This could indicate that individuals with higher incomes can travel farther for recreation, while those with lower incomes must use the bay for water recreation.

There was no significant difference between the two groups in distance from St. Albans Bay to a home address. The mean

distance for current users is 45.73 miles, while that for former users is 79.66 miles. These means are not significantly different from one another because of the high standard deviations of distance.

There was no significant difference between the two groups in distance from St. Albans Bay to a local address. A local address is defined as a location from which a trip to the bay is likely to be made, and may consist of a home, camp, or motel. For current users the distance traveled from a local address is 22.29 miles, while for former users it is 17.00 miles.

There was a significant difference between the two groups' perception of the bay's water quality. Former users viewed the bay's water quality as being worse than did current users. Given a choice of excellent, good, fair, poor, or terrible, the median evaluation of formers users was poor, while that of current users was fair. The X^2 statistic has a value of 26.00, which is significant at the 1-percent level. There are two possible explanations for this result. First, users may believe that the bay's water quality is acceptable, implying that recreational use is not based on water quality. The other possibility is that current users are reluctant to admit that the water quality is poor, since that admission would reflect poorly on their standards for recreation areas. They would be generous in rating the bay's water quality. If this is the case, there may be another reason for one group to stop using the bay while another continued to use it.

We examined familiarity with other sites to ascertain if individuals used alternative sites instead of the bay in 1982. Current users were significantly less familiar with other sites than former users. Current users were familiar with 1.40 sites other than St. Albans Bay, on the average, while former users were familiar with 2.03 other sites, including the site at which they were interviewed. The t-statistic has a value of 6.06, which is significant at the 1-percent level. A recreationist may be less reluctant to stop using the bay if it is one of several familiar recreation sites. Another explanation may be that those who became disenchanted with the bay searched for and discovered alternate sites. The direction of causality between familiarity with other sites and visiting St. Albans Bay in 1982 is not known and cannot be inferred from the data.

There was no significant difference between the two groups in the number of trips per season to northeastern Lake Champlain (table 1). Current users made about 11 of the trips to St. Albans Bay in 1982. When individuals were asked to estimate the number of visits they would make to the bay if it became

as clean as other parts of the study area, the number differed significantly (20.6 for current users and 9.2 for former users). The t-statistic has a value of 5.31, which is significant at the 1-percent level. This difference is probably due to the former users being composed of those who never made St. Albans Bay a major part of their recreational plans, and those former, frequent users who found other recreation sites which they prefer.

Table 1--Estimated trips to water recreation facilities by current and former users

Item	Northeast Lake Champlain	St. Albans Bay 1982	St. Albans Bay If clean
		Trips	
Current users	19.9	11.2	20.6
Former users	19.4	0	9.2

The two groups differ in the frequency of visits to St. Albans Bay, in their perception of the bay's water quality, income, familiarity with other sites, and the number of visits they would make to the bay if it was cleaner. It appears that the two groups are sufficiently different so that the benefits would likely differ and should be estimated separately.

TRAVEL COST METHOD

A widely used benefit estimation technique is the travel cost method. Used primarily to measure the demand for a recreation resource, the method can also be used as a contingent valuation technique for measuring the benefits from an improvement in environmental quality.

In the travel cost model, the cost of travel is used as a proxy for price in estimating demand functions for a recreation site. There are several ways of applying travel cost to determine the benefits from improving water quality. One involves estimating demand over several sites having different levels of water quality and including a measure of water quality as an explanatory variable. This variable can be used as a demand curve shifter to represent a hypothetical change in water quality (see Stevens, 1966; Reiling, et al., 1973; Bouwes and Schneider, 1979).

Data gathered in this study enabled us to use a different approach. The questionnaire was designed so that the individual observations approach, described by Gum and Martin (1975), could be applied to data pertaining only to St. Albans Bay.

The data from the 311 respondents who had recreational experience with the bay were used to estimate the model. The sample was divided between those who used the bay in 1982 (202) and former users (109). The travel cost method can be applied separately to each group. For current users, two demand curves were estimated; one for trips to the site under current quality conditions, and the other for trips to the site if it were cleaner. The area between the two curves and above travel cost measures consumer surplus attributable to an improvement in water quality. This results from the weak complementary relationship between travel to and environmental quality at a site (see Maler, 1974). For former users, only one demand curve, for use of the bay in the cleaner state, was generated. The area beneath this curve and above cost measures the benefits from improving water quality.

<u>Travel Cost Model</u>

The travel cost model used the number of trips to St. Albans Bay specified as a function of round trip travel cost to the bay, round trip travel cost to an alternative site, and income.

Number of Visits to the Bay in 1982

The number of trips to St. Albans Bay during the 1982 season was obtained from the questionnaire. Since the survey took place in July, the number of visits for 1982 is an estimate by the respondents. In many instances respondents could only estimate weekly use. These responses were expanded by a factor of 10 to approximate total seasonal use. The expansion factor was calculated by using weather data to determine the average number of weeks suitable for recreation between Memorial Day and mid-September (U.S. Environmental Data and Information Service).

Number of Visits to the Bay if Clean

The number of visits respondents would make to a cleaner St. Albans Bay was obtained from the questionnaire. Improved water quality was defined as being equal to that in most locations outside the bay. Weekly attendance estimates were also expanded by a factor of 10.

Travel Cost to St. Albans Bay	The cost variable accounts for both the vehicle operating costs and time costs for the trip to and from the bay. The vehicle cost is calculated by multiplying round trip mileage by the variable cost of operating an automobile, consisting of the costs of gasoline, oil, maintenance, and tires. The value used is $0.086 per mile, an average for four sizes of automobiles (American Automobile Association, 1982). Time cost measures the opportunity cost of time spent traveling to and from the site. Cesario (1976) reported that an approximate value for time spent on leisure activities is one-third the hourly wage rate. To calculate time cost the median value of the household income interval from the questionnaire was divided by 2,000 hours, then by 3. This hourly cost was then multiplied by travel hours to arrive at a dollar cost of travel time. Vehicle cost and time cost were summed to give the total cost of travel. We expected travel cost to have a negative influence on the number of current or contingent trips. For current users, the mean cost per trip is $8.61, while for former users it is $7.31. A t-test revealed no significant difference at the 5-percent level.
Travel Cost to Substitute Sites	Sand Bar State Park was selected as an alternative to St. Albans Bay. Vehicle and time costs were calculated in the same manner. The $1.50 entrance fee was added to the total cost of a visit. For current users the average cost of a visit to Sand Bar is $14.34, while for former users it is $11.81. A t-test revealed no significant difference at the 5-percent level. Kill Kare State Park was also examined as a possible substitute site. Its proximity to St. Albans Bay makes it a logical choice. Because of its proximity to the bay, and because visitors must pass the bay to get to Kill Kare, the cost is almost perfectly collinear with that of the bay. Travel cost to Kill Kare was not included in the model, with the acknowledged risk of specification bias. We expected the cost of the substitute to have a positive influence on the number of visits to St. Albans Bay.
Income	Household income was determined from the questionnaire. Income categories were specified in the questionnaire and the midpoint of each interval represented the range. We used $70,000 as an arbitrary midpoint for the $50,000 and greater income category. Canadian incomes were reduced by 25 percent to account for the exchange rate. Based upon the results of the comparison of the

groups, we expected that the coefficient estimated for income would be negative. A higher income allows recreationists to make more visits to more distant sites. The mean income for current users is $19,600, while that for former users is $24,500.

Functional Form

Functional form for the travel cost model can have a significant impact on the estimated benefits (Ziemar, Musser, and Hill, 1980). A functional form with several desirable characteristics is needed. The relationship between cost and number of trips is not expected to be linear. Economic theory suggests that the cross-partial derivative of quantity, with respect to price and income, must be nonzero (McConnell, 1975). Using the weak complementary relationship between travel and environmental quality places a restriction on the shape of the demand curve. The estimated demand curves must cross the price (cost) axis (Feenberg and Mills, 1980); otherwise, weak complementarity cannot be used to estimate benefits.

We used the semi-log model, with the independent variables in log form. It has most of the characteristics listed above. This form does not meet the requirement that the cross-partial derivatives of quantity, with respect to price and income, be nonzero. Application of other functional forms indicated that the coefficient on income is zero. Therefore, failure to meet the requirement is not critical.

Results

Ordinary least squares regression was used to estimate the demand equations. Three equations were estimated, two for current users with the bay in two water quality states, and one for former users with the bay in the cleaner state. The results are shown in table 2.

Table 2--Regression results for the travel cost demand equations

Variable	Coefficient value (student-t)		
	Current users		Former users
	Current bay	Clean bay	Clean bay
Constant	29.698 (2.06)**	44.199 (2.30)**	17.987 (.78)
Cost to St. Albans Bay	-6.315 (-6.22)***	-8.619 (6.46)***	-4.524 (3.40)***
Cost to substitute	6.581 (2.70)***	6.134 (1.90)*	4.120 (1.24)
Income	-2.818 (-2.72)*	-2.937 (-1.33)	-1.51 (-.44)
R^2	.258	.316	.129
F	19.66***	24.81***	4.26***
D. F.	170	161	86

*Significant at the 10-percent level.
**Significant at the 5-percent level.
***Significant at the 1-percent level.

In each of the estimated equations we saw the expected relationship between number of trips and travel cost. In all cases the estimated coefficients are significant at the 1-percent level. The sign of the coefficient for cost of trips to Sand Bar State Park is positive in all of the equations, as expected, and significant at the 10-percent level or higher in two equations.

Income has a negative coefficient in all of the estimated equations, although it is significant in only one. The implication is that recreation at St. Albans Bay is an inferior good, even in the cleaner state. St. Albans Bay apparently does not have the characteristics desired by individuals who can afford to travel and shop around. When the number of trips to the northeastern portion of Lake Champlain was used as the dependent variable in the travel cost model, the coefficient estimated for income

was both positive and significant. Water recreation on Lake Champlain is a normal good. We inferred that the economic models are consistent with the recreationists' behavior and that St. Albans Bay in its current condition is an inferior good.

The positions of the estimated demand curves for current users are as expected. The demand curve for the cleaner site lies to the right of the demand curve for the bay in its present condition, and based on a Chow test, the two estimated equations are significantly different at the 1-percent level ($F_{4,331} = 11.99$). The improvement in water quality induces an increase in the demand for visits to St. Albans Bay.

The Chow test was used to test the two equations estimated for the cleaner site. The results rejected the hypothesis that the contingent demand equations are the same at the 1-percent level ($F_{4,247} = 5.83$). The results strongly support the separate treatment of current and former users of the bay. The demand curve for former users lies to the left of that for current users, indicating that former users express a lower level of demand for the contingent site than current users, although former users visit Lake Champlain as often as current users. A cleaner St. Albans Bay is not as attractive to formers users as to current users. We surmised that former users are reluctant to give up recreation time at other familiar sites.

Travel Cost Benefit Estimates

We calculated the area beneath each estimated curve by taking the integral under the curve, between current travel costs to St. Albans Bay, and the cost at which the number of visits falls to zero. We followed this procedure for each observation, using the individual's travel costs and income to position the estimated functions and to determine maximum cost.

For current users the mean difference in the area between the two estimated demand curves is $123. This measures the annual per capita benefits to current users from improved water quality.

For former users the mean area beneath the estimated demand curve and above costs is $97. This also measures the per capita annual benefits to former users from improved water quality. A t-test revealed that the per capita benefits accruing to each group are significantly different from each other at the 1-percent level ($t = 4.45$). This supports the separate treatment of former and current users.

The estimated benefits or each user group can be used to calculate the aggregate recreation benefits from improved water quality. Because the results are expressed as benefits per person, aggregation requires knowledge of the number of individuals benefiting from improved water quality. The average number of recreationists in each user group was estimated using attendance records for the State parks and information from an attendance survey conducted in 1983. A detailed description of this procedure appears in Appendix B. A total of 2,732 current users and 2,069 former users was calculated. Multiplying the number of individuals in each group, by the estimated benefits for that group, results in aggregate benefits of $536,700 per season. A summary of the total benefits derived from improved water quality over 10 and 50 years is presented in table 3.

Table 3--Recreational benefits from water quality improvement using the travel cost method

Discount rate[a]	Improvement of water quality		Maintenance of current water quality	
	10 years	50 years	10 years	50 years
		1,000 dollars		
3.9	4,375	11,730	1,113	2,972
7.875	3,622	6,662	922	1,688
11.8	3,058	4,531	775	1,148

[a]The discount rates are 0.5, 1, and 1.5 times the recommended discount rate for Federal water projects for 1982.

The travel cost results also revealed the benefits of keeping St. Albans Bay from deteriorating to the point where it would not be used. This is the area beneath the demand curve for the current bay by current users. The per capita benefits to current users are $50. This implies an aggregate annual benefit of $136,600. These benefit estimates are summarized in table 3 for 10 and 50 years.

CONTINGENT RATING METHOD

Contingent rating is a technique which uses utility information to indirectly measure the benefits from improved environmental quality. It uses a contingent valuation procedure to enumerate preferences for a clean rather than a polluted site, and uses these preferences to derive individual benefits from improving

quality. The theory of this technique is presented in Appendix C. Contingent rating was applied to a group of survey respondents who were historic users of St. Albans Bay.

<u>Application of the Contingent Rating Method</u>

The contingent rating game requires a sample of recreationists who use St. Albans Bay and who are familiar with cleaner water. This sample was randomly selected from respondents who made recreational trips to the bay. The 20-minute interviews were conducted at the respondents' homes to minimize interference with their recreational activity.

A limited travel budget restricted sampling to those who live within 40 miles of St. Albans Bay. Because most historic users (85 percent) reside in this zone, we obtained a representative sample.

The contingent rating game was conducted during two trips to Vermont, August 21-27, and September 13-21, 1982. We made initial contact by phone and arranged a time for the interview. We completed 66 interviews.

<u>Description of the Rating Procedure</u>

The survey instrument of the contingent rating method is the prospect table described in Appendix C. Table 4 contains two prospects or packages, each consisting of trips to St. Albans Bay in 1982 and trips to the bay with cleaner water.

Table 4--Prospect table for St. Albans Bay

Prospect I	Prospect II
a trips to the bay as it is now	c trips to the bay as it is now
b trips to the bay with cleaner water	d trips to the bay with cleaner water

We described the study to the interviewee and then presented the prospect table. We did not describe the current bay as dirty or polluted. We did not want to give the impression that the bay was dirty, because the interviewee may think that the water quality is acceptable.

We used a two-step procedure to explain and initiate the game. First, we described the hypothetical setting. We

asked the interviewee to imagine starting with no trips for water recreation, and that recreation days would be allotted in nonseparable packages. This was necessary to force the respondent to compare the prospects carefully.

The interviewee was then presented with two prospects. The first consisted of one trip to the cleaner bay, and the second consisted of one trip to the cleaner bay and one trip to current bay (table 5). We asked the interviewee to imagine that the water quality of the cleaner bay is similar to that outside of the bay. We mentioned familiar sites such as Kill Kare State Park, Sand Bar State Park, and Grand Isle. We emphasized that Prospect I contained only one trip for recreation while Prospect II contained two trips.

Table 5--Prospect table for St. Albans Bay--game 1

Prospect I	Prospect II
i) 0 trips to the bay as it is now	iii) 1 trip to the bay as it is now
ii) 1 trip to the bay with cleaner water	iv) 1 trip to the bay with cleaner water

Rating = 10.

After being introduced to the prospect table, we asked the interviewee to select the preferred prospect. After the interviewee selected a package we introduced the rating system. We explained that Prospect I had an arbitrary rating of 10 as the measure of enjoyment one would get from consuming it. We asked the interviewee to give Prospect II a rating, reflecting the intensity of feelings for the selection. If the respondent preferred Prospect I, then we explained that the alternative, Prospect II, should be given a rating of less than 10. If the interviewee preferred Prospect II then it should receive a rating of greater than 10.

After a package was selected and Prospect II was rated, Prospect II was altered by adding one more trip to the cleaner bay or one more trip to the current bay. We again asked the respondent to compare the two prospects, select

one, and rate the new Prospect II relative to Prospect I. Prior to the interview we decided whether the game would proceed by adding cleaner trips to a fixed level of current trips or vice versa. On the utility map, the rating of the points moved along a row or up a column, respectively (figure 2).

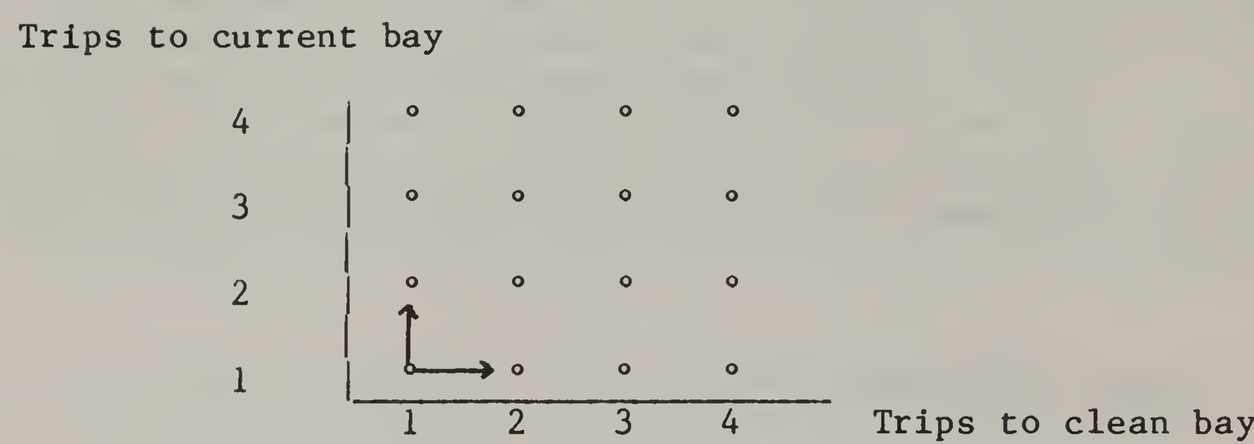

Figure 2. Directions in which the rating game proceeds.

After completing the first row (column), we changed Prospect II so that the first package of the second row (column) could be evaluated. For instance, if the first row in figure 2 was completed, Prospect II for evaluating the first point of the second row would contain two trips to the current bay and one trip to the cleaner bay. Then, additional trips to the cleaner bay would be added to the two trips to the current bay until the second row was completed. We repeated this procedure until 36 packages had been rated (a 6 x 6 grid of points). We believed that this was about the maximum number of points the respondent could rate before becoming disinterested in the game.

The rating procedure resulted in 66 indifference maps. 60 yielded consistent results which could be used to estimate benefits. Appendix C shows how benefits can be determined when the indifference maps are convex to the origin (the classical case). Only three individuals expressed preferences which resulted in convex indifference curves. Fifty had positively sloped curves, three had concave-to-the-origin curves, four had horizontal indifference curves, and one had vertical curves. We easily adopted the technique to derive benefits from the unexpected outcomes.

Contingent Rating Benefit Estimates

For current users, the contingent rating method gave a mean benefit estimate of $54, while for former users it was $40. These benefit measures are not statistically different. These

per capita benefit measures can be applied to the 2,732 average current users and 2,069 average former users of the bay, similar to the travel cost results. This results in an aggregate seasonal benefit of $230,300 from providing improved water quality. A summary of what this means over alternative time frames and discount rates is presented in table 6.

Table 6--Recreational benefits from a water quality improvement using the contingent rating technique

Discount rate[a]	10 years	50 years
	1,000 dollars	
3.9	1,877	5,033
7.875	1,554	2,858
11.8	1,312	1,944

[a]The discount rates are 0.5, 1 and 1.5 times the recommended discount rate for Federal water projects for 1982.

COMPARISON OF BENEFIT ESTIMATES

The benefit estimates from the contingent rating method are different from those derived using the travel cost method. These results have a significant impact on the estimated aggregate benefits resulting from improved water quality in St. Albans Bay. Using the results from the contingent rating method, the projected annual benefits are $230,300, compared with $536,700 for the travel cost method.

There may be several reasons for this difference. The contingent rating sample did not include individuals who lived more than 40 miles from the bay. The individuals excluded pay a higher price for recreation at the bay than those included in the sample. A modest increase in the frequency of their visits implies a fairly substantial level of willingness to pay. This could raise the mean benefits for both user groups. It is doubtful that the small proportion of long-distance visitors would realize enough benefits to raise the overall means substantially.

The structure of the methods may have influenced the difference in benefit estimates. The results of the contingent rating method are not systematically smaller in magnitude than the travel cost results across individuals. We calculated the travel cost benefits, accruing strictly to members of the contingent rating sample, using the estimated travel cost demand equations. The rankings of sample observations, by benefits, for the two methods are not the same based on a Spearman rank test. If the difference between the travel cost and contingent rating benefits was systematic, the rankings would be the same.

The travel cost benefit estimates are derived from the same estimated functions. The behavior of one individual influences the location of the fitted curve, and the estimated benefits for all members of the sample. There is no such interdependence with the contingent rating method. Only the individual characteristics influence the estimated benefits.

A primary reason for the difference in the results is our inability to specify the travel cost demand function. We did not account for differences in taste or the availability of other recreation opportunities. This may have affected the estimated demand curve and benefits may be overestimated.

Another factor may be the way the data was clustered. If the observations are clustered in a relatively small region of economic space, then much of the fitted curve may be an extrapolation, based upon the behavior of the clustered observations. We cannot make inferences about behavior in these regions without observations.

Overestimation of the number of visits to the cleaner bay may contribute to an overestimate of aggregate benefits. Due to the interdependence of observations in estimating the travel costs demand curves, overestimation of contingent demand by many indivduals would affect the sample's benefit estimates. Because individual estimates for the contingent rating method are independent, the overestimate of contingent demand would not have as great an effect on the mean and aggregate benefit estimates.

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APPENDIX A

Sample Questionnaire

Hello, I'm (Marc Ribaudo). I am working on a study of water recreation on Lake Champlain. Could I ask you a few questions about your recreation? Your answers will remain confidential. You may refuse to answer any question you find objectionable.

1. What type of recreation do you participate in here?

   ________ Swimming
   ________ Boating
   ________ Fishing from shore
   ________ Fishing from a boat
   ________ Picnicking
   ________ Enjoying the scenery of the shoreline

2. What is the number of people in your party? (Came from home) _______

3. Is this the only stop on this trip from home (if you do not live in the immediate area)? Yes _______ No _______

   If no, where else have you been or where else are you going: (major destinations)

   ----

4. How many times during the season do you participate in recreation such as this: __________

5. Are you familiar with other parts of Lake Champlain: (List)

   ____

   ____

   ____

   ____

6. (If not mentioned in 3) Are you familiar with St. Albans Bay? ______ Yes _______ No

7. (If yes) Have you ever used it for recreation?

   _______ Yes _______ No

8. (If Yes) What types of recreation?

________	Swimming	________	Ice Fishing
________	Boating	________	Sightseeing
________	Fishing from shore		Fishing from
	Picnicking along	________	a boat
________	the shore	________	Other ________

9. How many times will you recreate here this year? ______

10. (If Yes) When was the last time you used St. Albans Bay for recreation? ________ (year)

11. (If Yes) What was your impression of the water quality at St. Albans Bay? ____
____

12. (If Yes) If St. Albans Bay was to be cleaned up so that it is as clean as the rest of the lake, how many days would you spend there? _________

Now I would like some information about you for the purposes of data classification.

13. Age ________

14. Which of these categories includes your family income for last year?

A. < 10,000	F. 30,000 - 35,000
B. 10,000 - 15,000	G. 35,000 - 40,000
C. 15,000 - 20,000	H. 40,000 - 45,000
D. 20,000 - 25,000	I. 45,000 - 50,000
E. 25,000 - 30,000	J. > 50,000

15. What is your occupation? ______________________________

16. What is the occupation of other members of your household?

Name	Occupation
________________________	____________________
________________________	____________________
________________________	____________________

17. How many persons are in your household?

_____________ Total

_____________ Children (under 18)

_____________ Adults

18. In case we need some more information:

Name:

Home Address:

Home Phone:

Local Address:

APPENDIX B

Calculation of User Population

Each of the benefit measures pertains to a different segment of the recreation population, and the number of recreationists in each can be calculated by using attendance records for the State parks in the study area, and information gathered during the survey.

The site-by-site approach allowed us to use attendance data available from the Vermont Department of Forests, Parks, and Recreation. We assumed that the site at which a recreationist was interviewed was the primary recreation site. At each survey site we first determined the number of trips the interviewees made to the site in 1982. We also assumed that all recreational trips, other than those to St. Albans Bay, were made to the survey site, since information about trips to other sites was not obtained. The percentage of trips made by current users of St. Albans Bay was determined from survey data. This percentage was then applied to the total attendance at the site in 1982, and we determined the number of site visits made by those who also used St. Albans Bay. Dividing this number of trips by the average number of trips made to the survey site by interviewees, we determined the number of individuals who were also current users of St. Albans Bay. This procedure was carried out for Kill Kare, Sand Bar, and the Grand Isle State Parks.

In order to complete the estimation we used the same procedure for interviewees at St. Albans Bay. Because no attendance records are available for St. Albans Bay State Park beyond 1979, we estimated the total number of visits to the bay. We conducted a survey to estimate attendance at St. Albans Bay during the 1983 recreation season. Total attendance was estimated to be about 26,100 user days.

Before we estimated the number of current users, who were assumed to primarily use St. Albans Bay, the total number of visits to the bay was adjusted to account for trips made by users of other sites. Those identified at the other sites made approximately 3,300 trips to the bay in 1982. This left 22,800 trips to be accounted for.

We used the same procedure to calculate the number of users at St. Albans Bay. Although the members of this subsample were interviewed at St. Albans Bay, a small percentage of them were not familiar with the bay. Some were former users who came to see if the bay was suitable for recreation, and not for recreation itself. The percentage of visits to the bay for recreational purposes by current users was 98. The survey area had 2,732 current users.

We followed the same procedure to calculate the numbers of former users from each survey site who might return if the bay became cleaner. For those surveyed at a particular site, the percentage of trips to that site by former users was translated into total number of former users at that site, using attendance and average visits information. A total of 2,069 former users in the study area was calculated.

APPENDIX C

Conceptual Development of the Contingent Rating Method

The contingent rating method relies on a survey approach similar to the Ramsey model used by Sinden (1974) and by Findlater and Sinden (1982) in their work on indifference mapping techniques. The survey instrument, or prospect table, is shown in table 7. It consists of two prospects, each containing quantities of two goods, A and B. Prospect I is assigned an arbitrary utility rating of R*. The object of the survey game is to rate Prospect II relative to Prospect I, by giving Prospect II a rating which reflects the strength of the respondent's preferences. By systematically varying Prospect II and by keeping Prospect I constant (treat it as a numeraire), a series of points or rated packages are generated, and can be treated as points on an indifference map.

Table 7--Prospect table for utility estimation

Prospect I	Prospect II
i) days at A	iii) days at A
ii) days at B	iv) days at B

Utility = R*.

As an example, let the prospects contain days of recreation at some recreation site (A), and at an alternative site (B). For the initial game, outcomes (i) and (iii) are assigned a and c days at A, respectively, such that c is greater than a. Outcomes (ii) and (iv) are both assigned b days at B. Prospect I is then given an arbitrary rating of 1.0 utile. The utility level of Prospect II remains unknown (see table 8).

Table 8--Prospect table for utility estimation--game 1

Prospect I	Prospect II
i) a days at A	iii) c days at A
ii) b days at B	iv) d days at B

Utility = 1.0.	Utility = t.

A subject is asked to evaluate these two prospects and to rate Prospect II relative to Prospect I by assigning a value to t. The following equality then holds:

$t(U(a,b)) = U(c,b)$

The combination (b,a) is a point on an indifference curve with a value of 1 utile, while (b,c) is a point on a curve with a value of t (fig. 3). Additional points are rated as follows:

1) Values a and b are held constant and new quantities for days at A replace c in the prospect table in outcome (ii) (for example, e and g days at A). Each of these is evaluated and the results give the values of points vertically above (b,a) in fig. 3.

2) Outcome (iv) in Prospect II is changed to d days at B and (iii) is assigned a days at A. The result of this evaluation is the utility rating for the point (d,a).

3) The procedure in step 1 is repeated to give the values of the points above (d,a).

4) Outcome (iv) is given subsequent values of f,h,... days at B, and steps 1 through 3 are repeated to derive utility ratings for a selected set of points on the map. Indifference curves can be fitted using the rated points for reference.

days at A	g	.	.	.	.	
	e	.	.	.	.	
	c	t	.	.	.	
	a	1.0	.	.	.	days at B
		b	d	f	h	

Figure 3. Rated points of indifference.

In the contingent rating model, both good A and B are defined as visits to the same site. Each site is characterized by a different level of water quality. Part of the procedure is a description of the site in a hypothetical state.

Assuming that the respondent can play the game in the hypothetical setting, the result would be an indifference map which reflects the individual's relative preference for the two sites. Because two goods are defined as being identical

except for water quality, the shape of the map would reflect the individual's preference for improved water quality at the site. If the individual is indifferent about the water quality at two sites, the individual would also be indifferent about the sites. The marginal rate of substitution (MRS) between the two sites would be one, indicating that the two are identical. The indifference map would be a series of straight lines with slopes of -1. If the cleaner site is preferred, the indifference curves must have a MRS of the current site for the cleaner site which is greater than one.

When coupled with additional information the indifference map can be used to estimate the benefits from improving water quality from the current level to that of the hypothetically cleaner level (fig. 4).

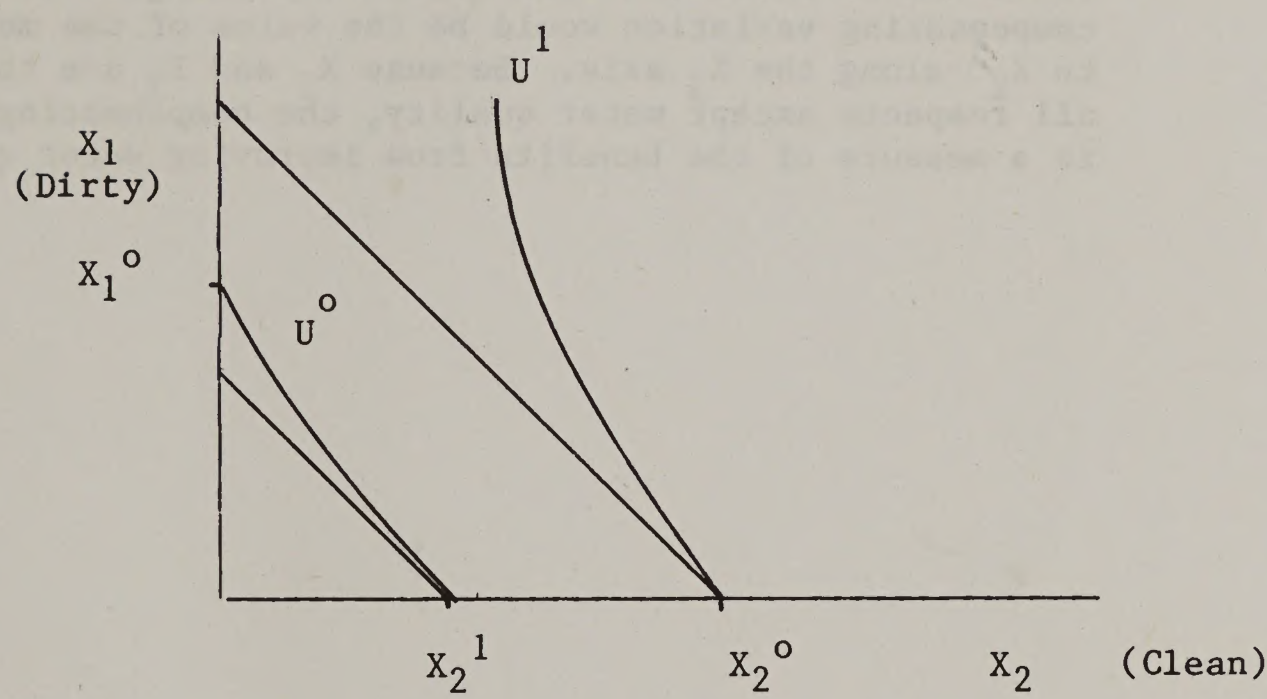

Figure 4. Estimation of benefits using the indifference map.

Let X_1 be trips to the dirty site, and X_2 trips to the hypothetically cleaner site. Before the water quality is improved the consumer is on the X_1 axis of the indifference map. Let X_1^o be the observed number of trips the individual makes to the site under current conditions and at the current price (price is measured in terms of travel and time costs). Now assume that the clean site is made available. When X_2 is made available the indifference map can be drawn.

The number of trips to the recreation site in its cleaner state can be determined by asking the respondent. Assuming

an unbiased, accurate response, the answer would be the utility maximizing solution to the indifference map, given a budget which equals the number of trips to the hypothetical site times the price. The solution to the utility maximization problem is a corner solution along the X_2 axis because the slope of the budget line is -1 (because travel and time costs for each site have to be the same), and the MRS is greater than one. Although the two goods cannot exist at the same time the observed number of visits to the cleaner site is the same as the utility maximizing position, given the two sites are available simultaneously.

An indifference curve passes through each of the observed points, X_1° and X_2°. The definition of the welfare measure, compensating variation, is that amount of income which can be taken from an individual after a change has occurred and still leave him no worse off than before the change. In fig. 4 the compensating variation would be the value of the move from X_2° to X_2^{1} along the X_2 axis. Because X_1 and X_2 are the same in all respects except water quality, the compensating variation is a measure of the benefits from improving water quality.

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